OLLI SG 492
Plate Tectonics

Session 6 - October 24, 2022

Today’s Meeting

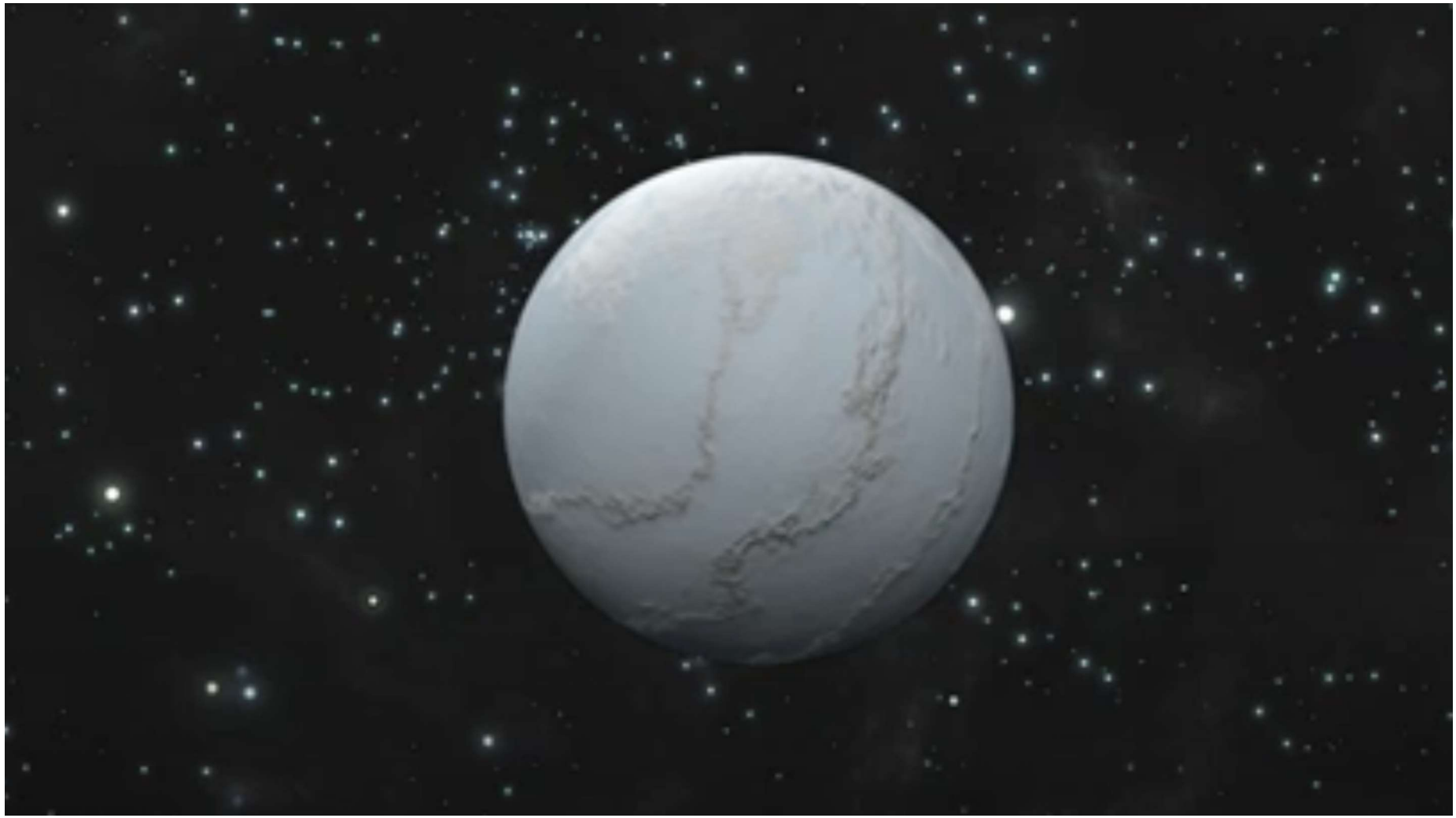
- Finish presentation on the Supercontinent Cycle.
- Snowball Earth.
- Pangaea - Formation and Breakup.
- Hot Spots and Basaltic flows.
- Hawaii and Yellowstone.

Plate Tectonics

Mantle Convection

- BBC video clip on Mantle Convection.

Snowball Earth

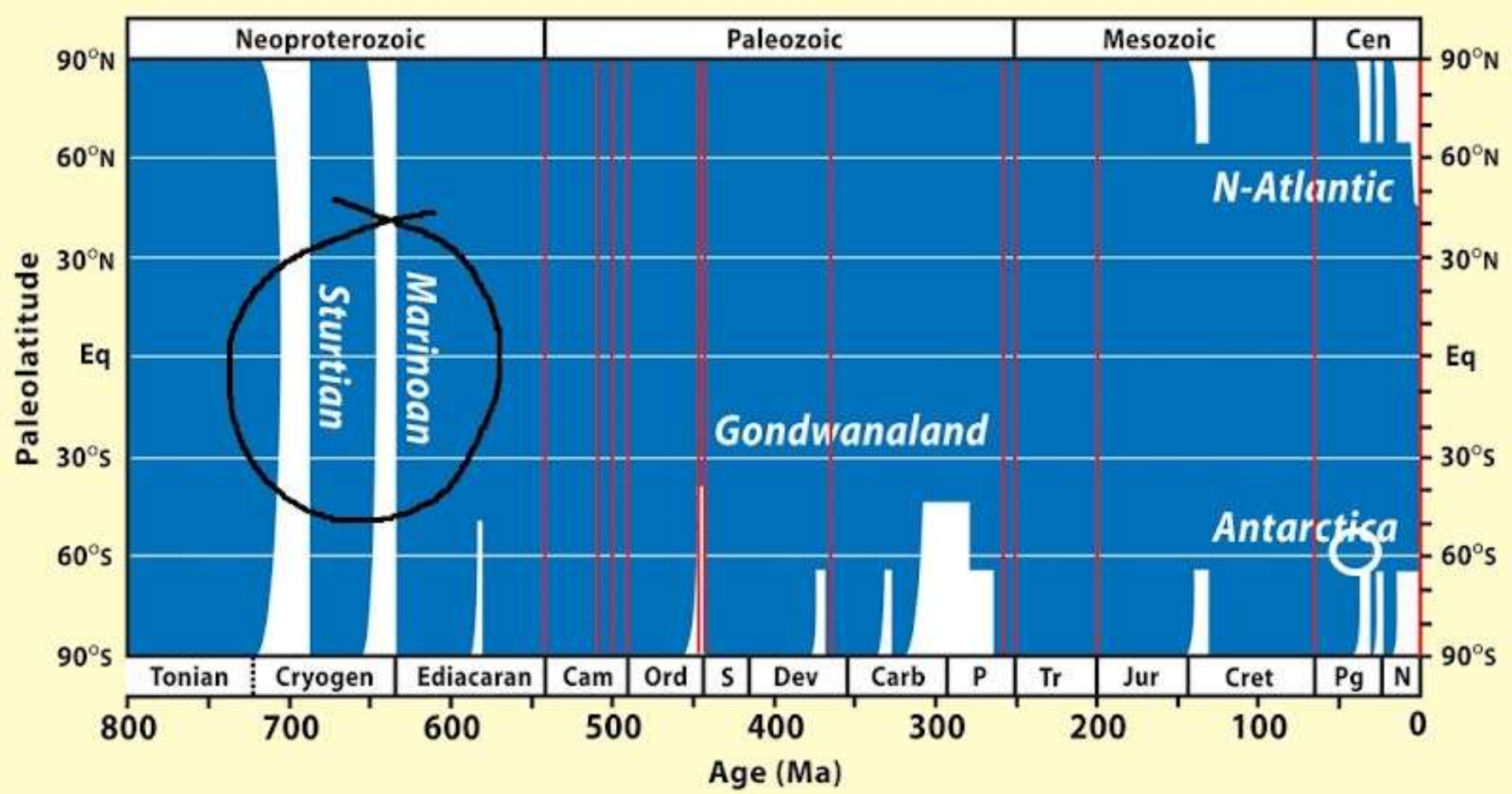


Snowball Earth

- Ice and glaciers from pole to pole, even at the Equator, frozen oceans.
- During the breakup of Rodinia, all landmasses were at or near the Equator.
- Wet, tropical climate resulted in an increase in rock weathering, and an increase in microbial and algal photosynthesis. These depleted the CO_2 in the atmosphere.
- As the Earth cooled, a tipping point was reached. Ice caps formed at the poles.
- Positive feedback loops accelerated the growth of the ice caps.
  - Sunlight was reflected back into space from the growing ice caps, further cooling the planet - the albedo effect.
  - Rock weathering and photosynthesis accelerated the depletion of CO_2 further cooling the planet.

Snowball Earth

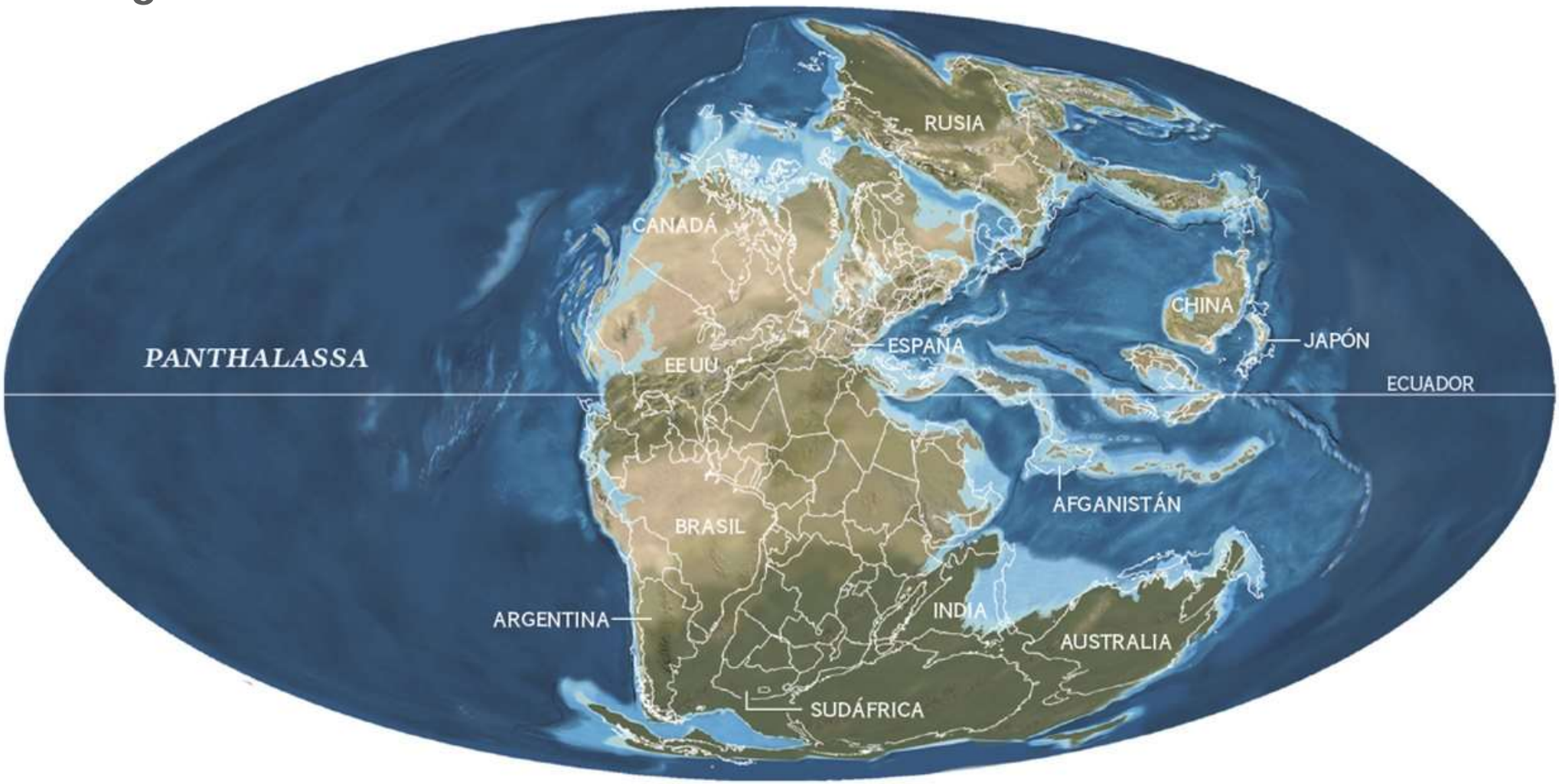
Extent of Glaciation



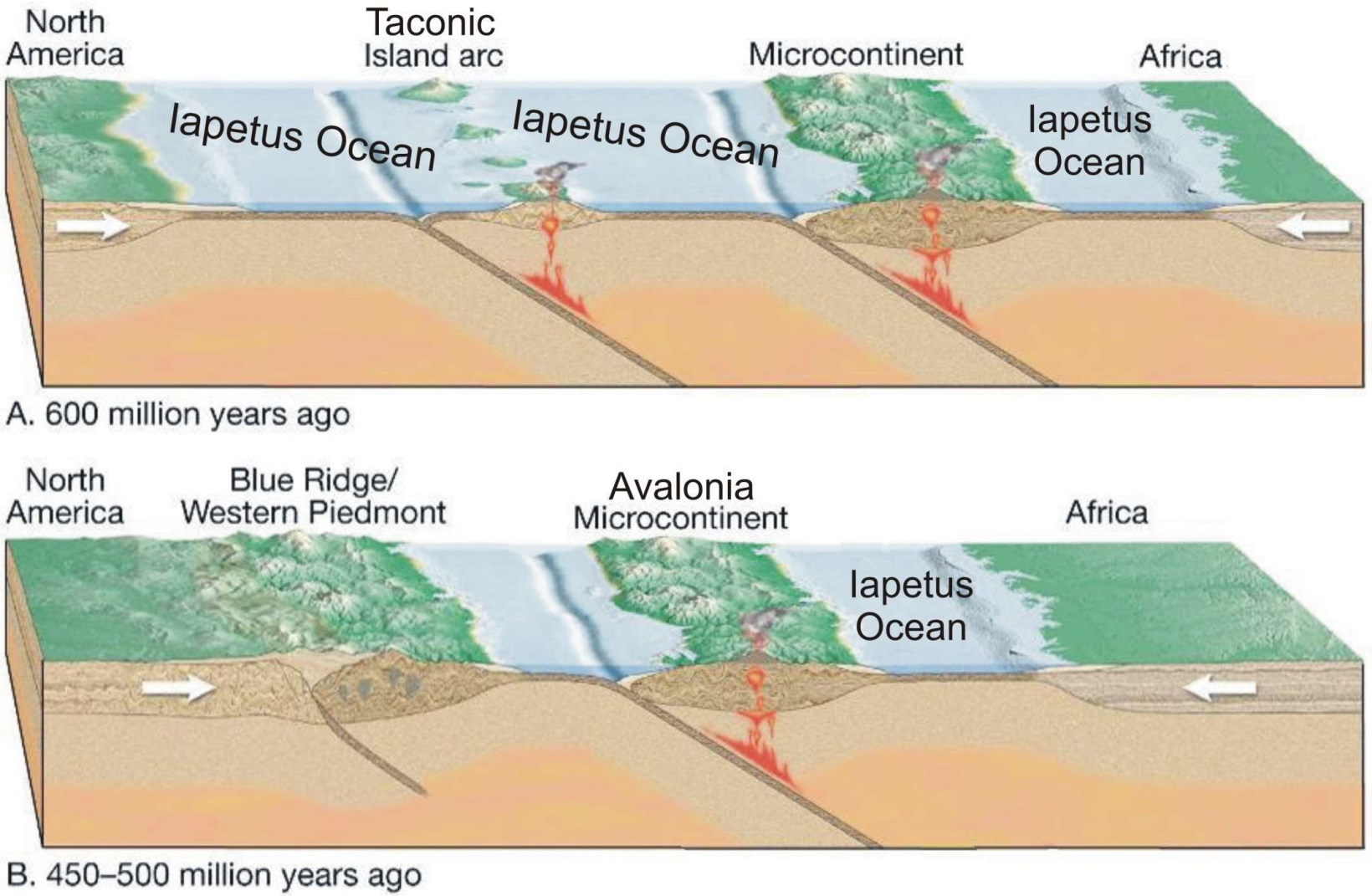
Snowball Earth

- Hazen video clip 37.1 - from 3:45 to 8:35
- Hazen video clip 37.2 - from 10:10 to 14:00

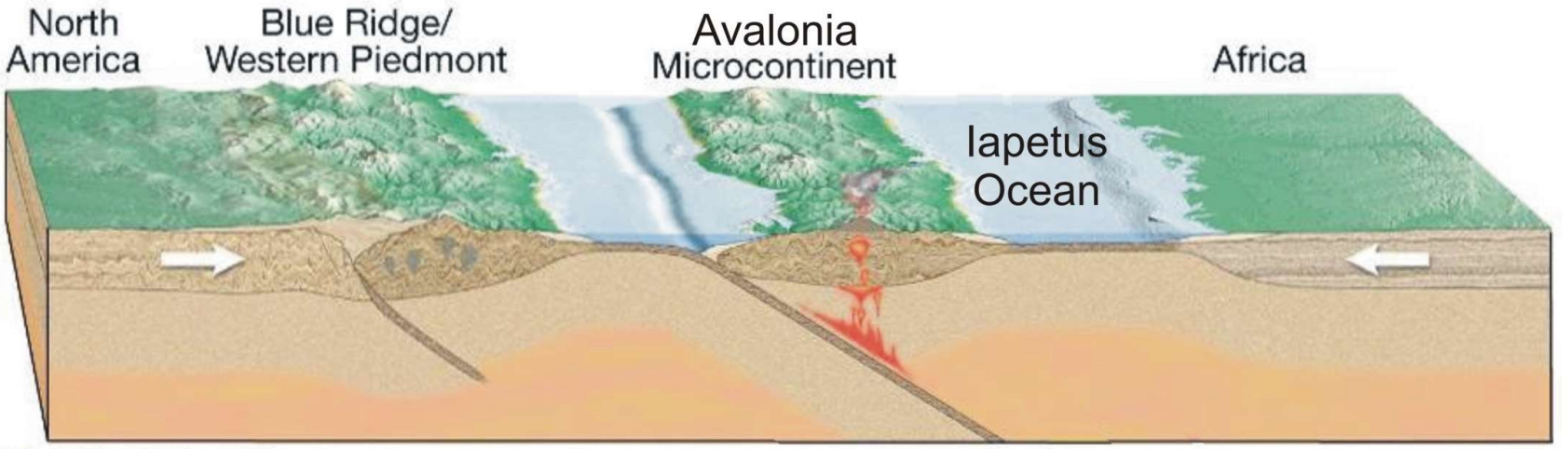
Supercontinent Cycle
Pangaea



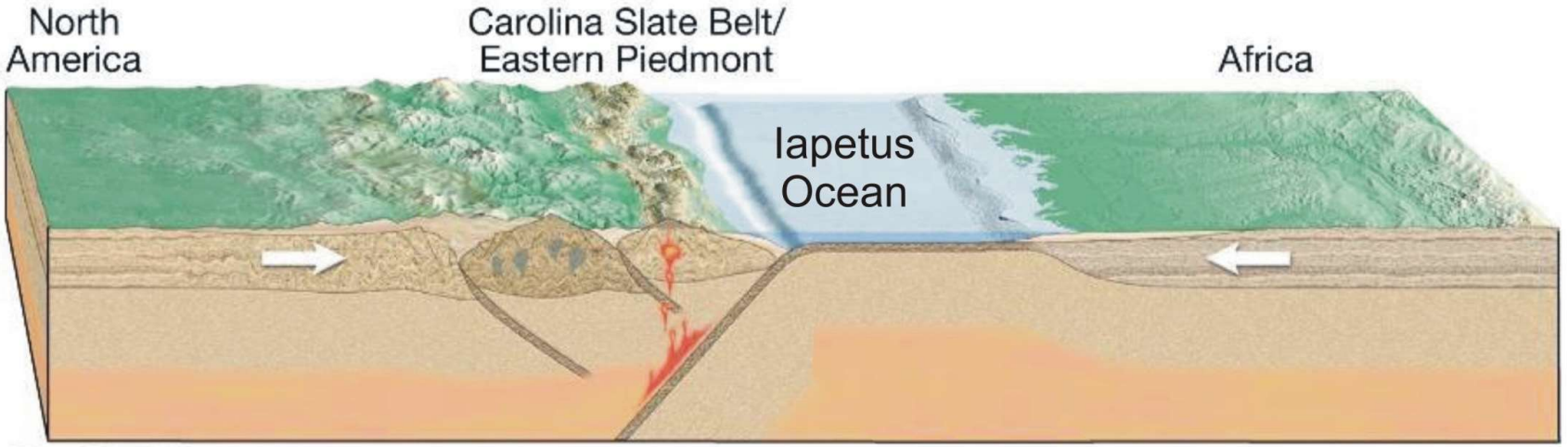
Formation of Pangaea



Formation of Pangaea

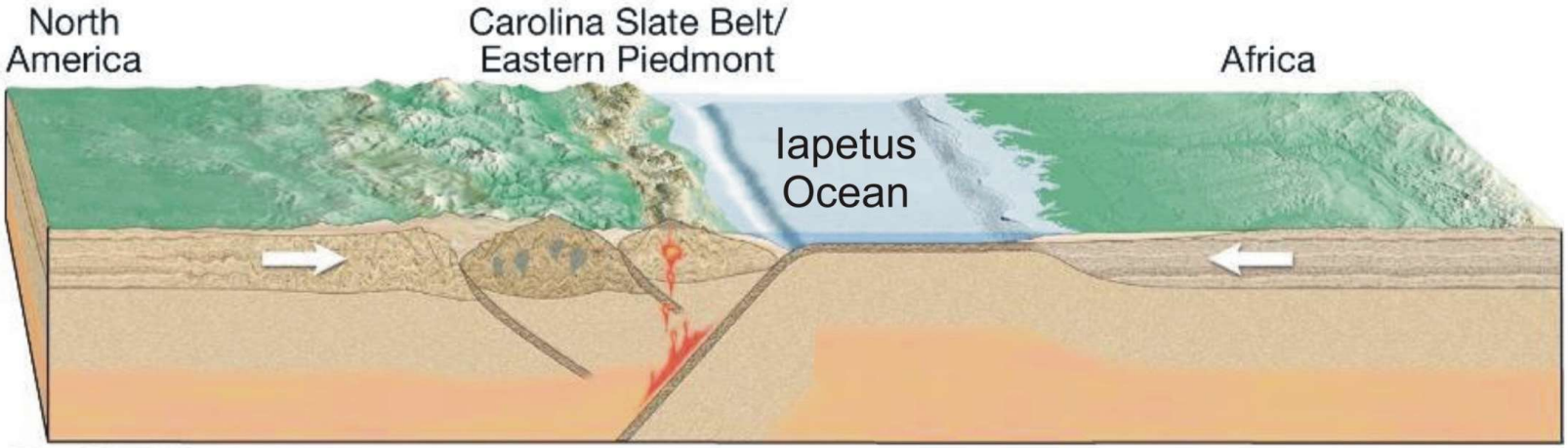


B. 450–500 million years ago

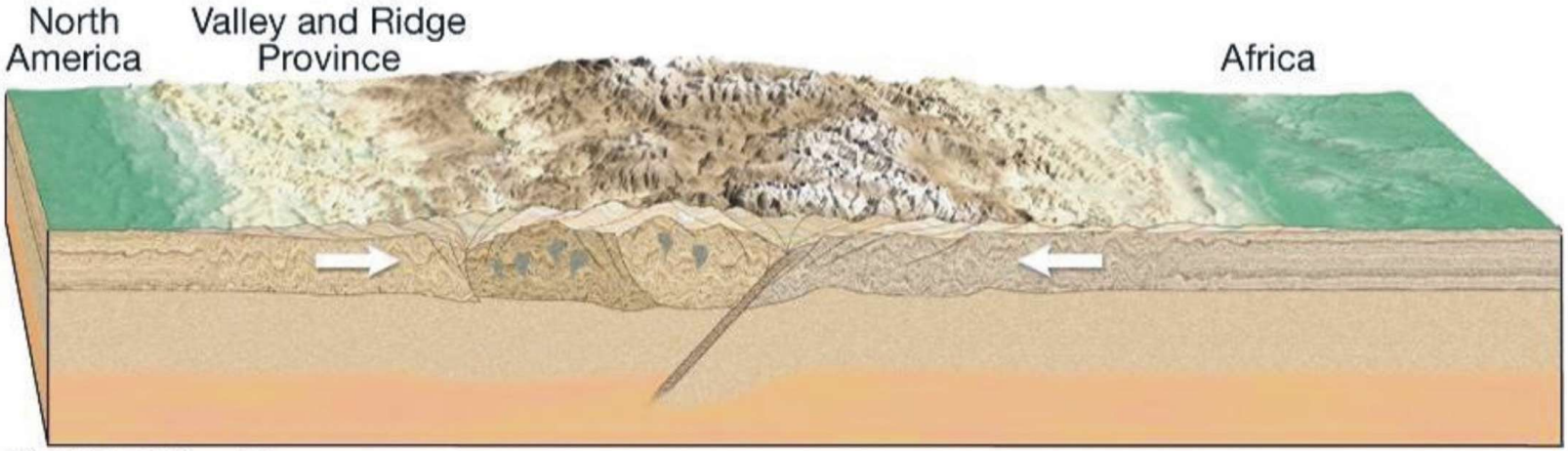


C. 400 million years ago

Formation of Pangaea



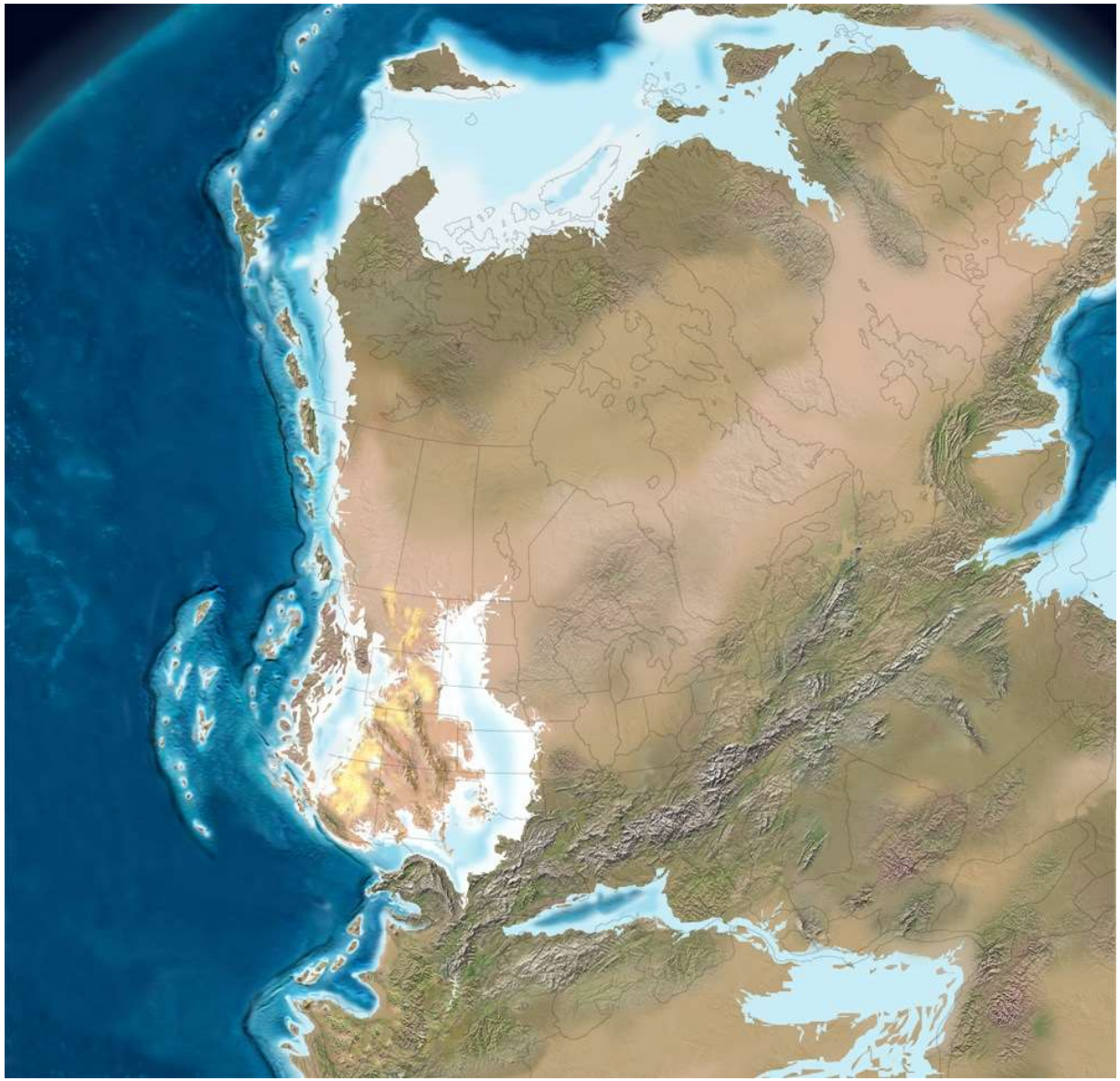
C. 400 million years ago



D. 250–300 million years ago

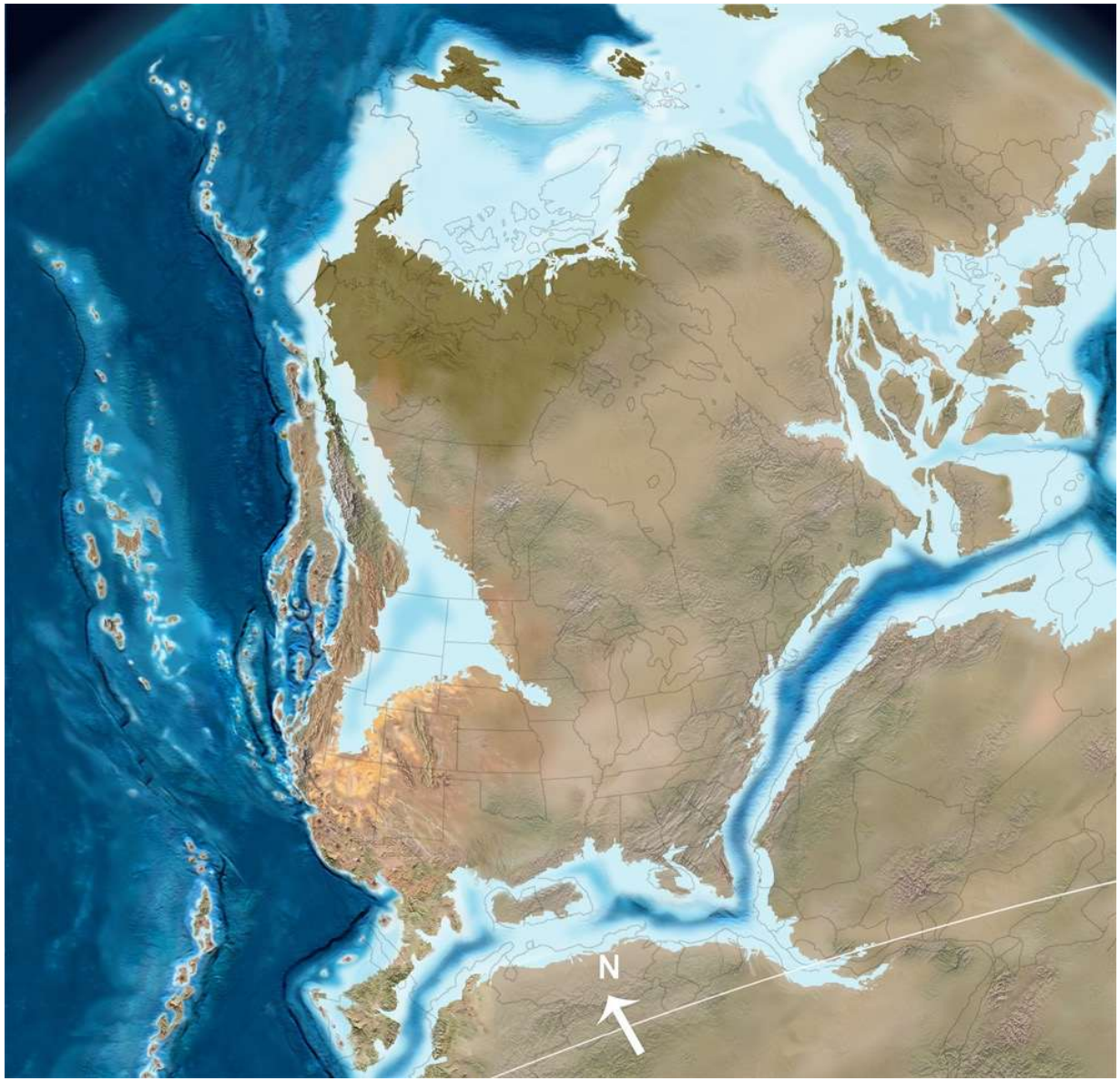
Formation of Pangaea

290 MYA

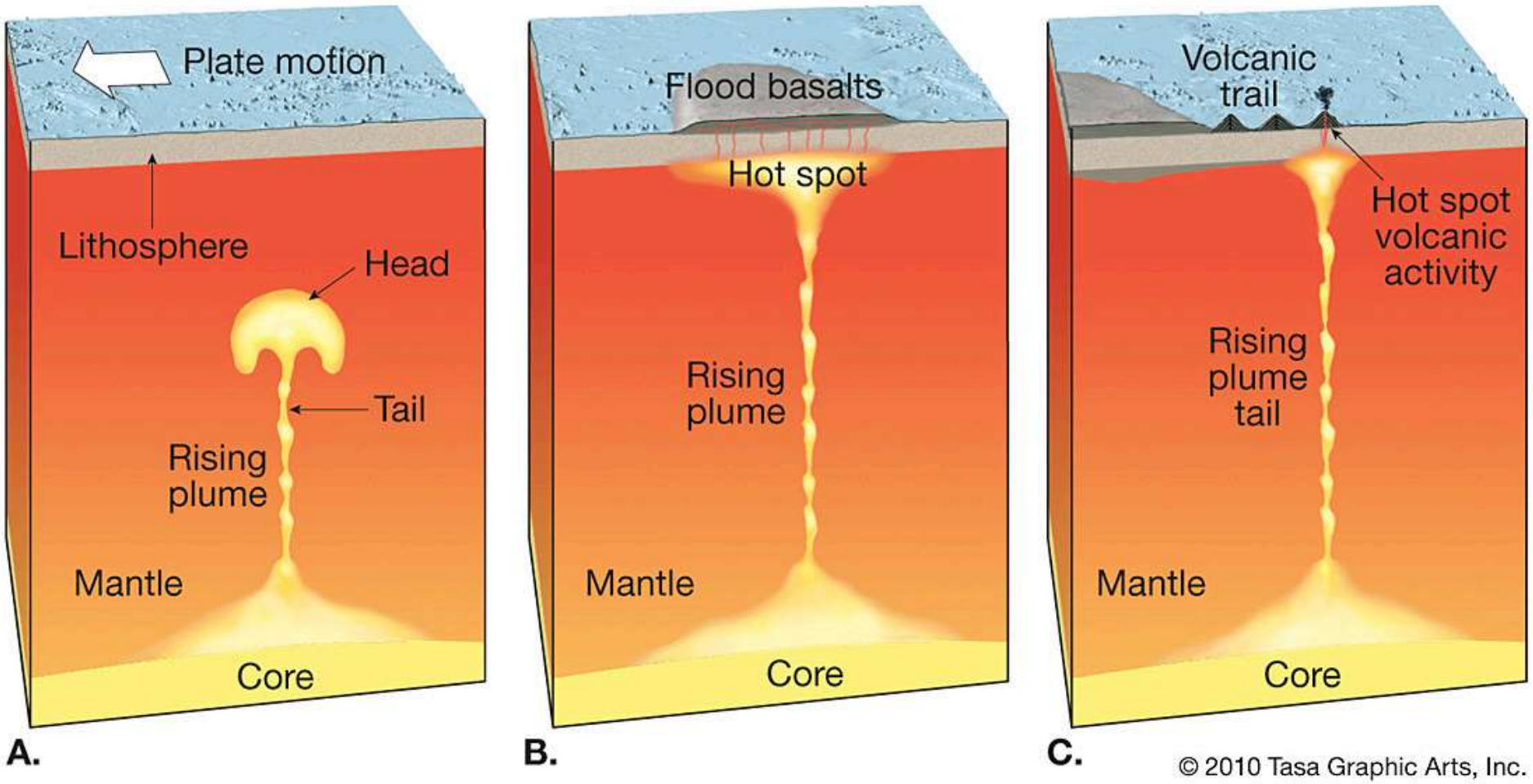


Breakup of Pangaea

170 MYA



Hot Spots



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Breakup of Pangaea

Role of Hot Spots

Approximate surface location of mantle plumes prior to the breakup of Pangaea. The location of the plume that produced the Central Atlantic Province is unknown and may have involved a superplume that was deflected by the unusually thick lithosphere beneath western Africa. The Central Atlantic Province includes lava flows, sills, and dikes in northeastern South America, northwestern Africa, southwestern Europe, and eastern North America.

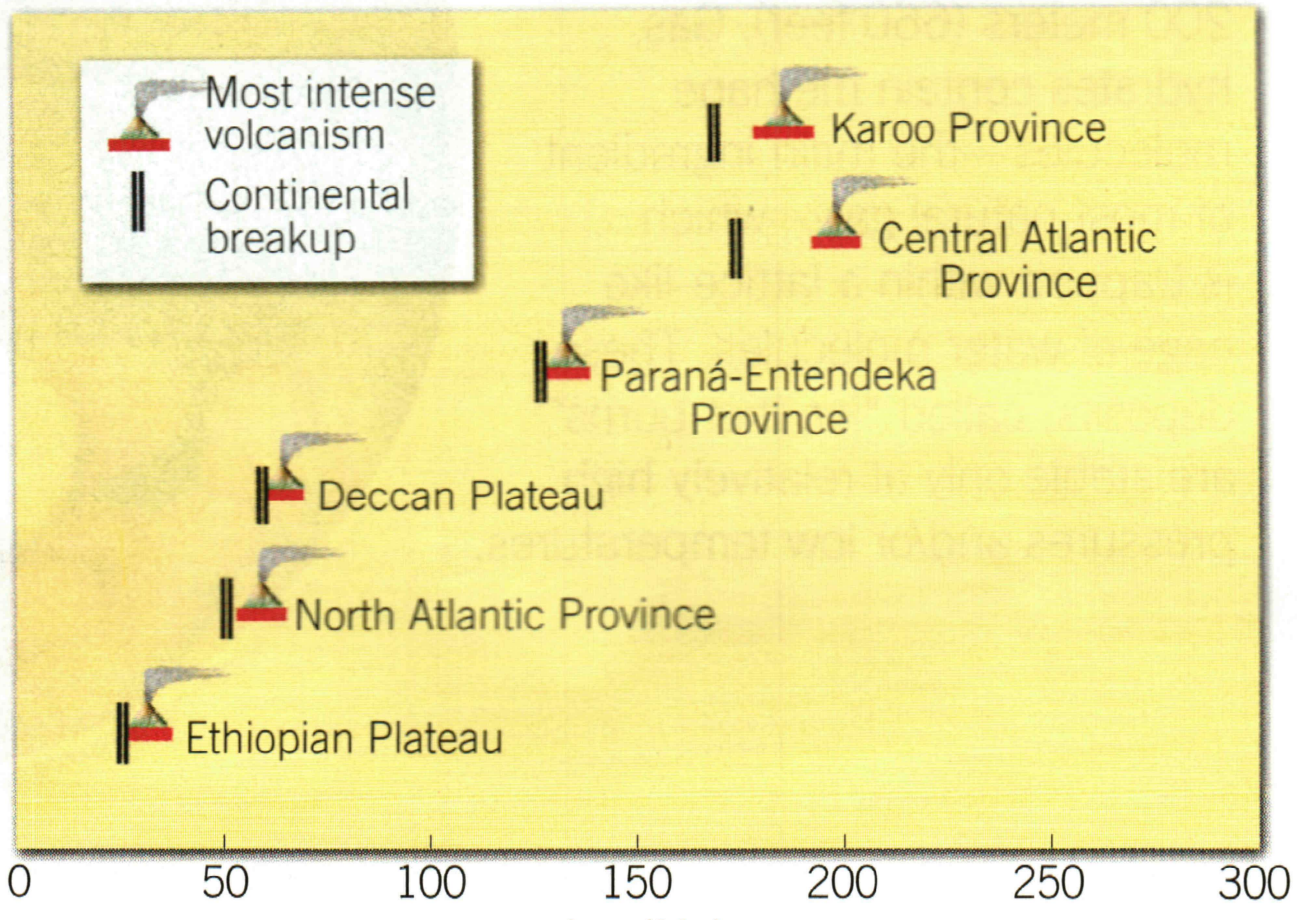
FIGURE 13.25 The possible role of mantle plumes in the breakup of Pangaea

(Data after Courtillot et al.)

Breakup of Pangaea

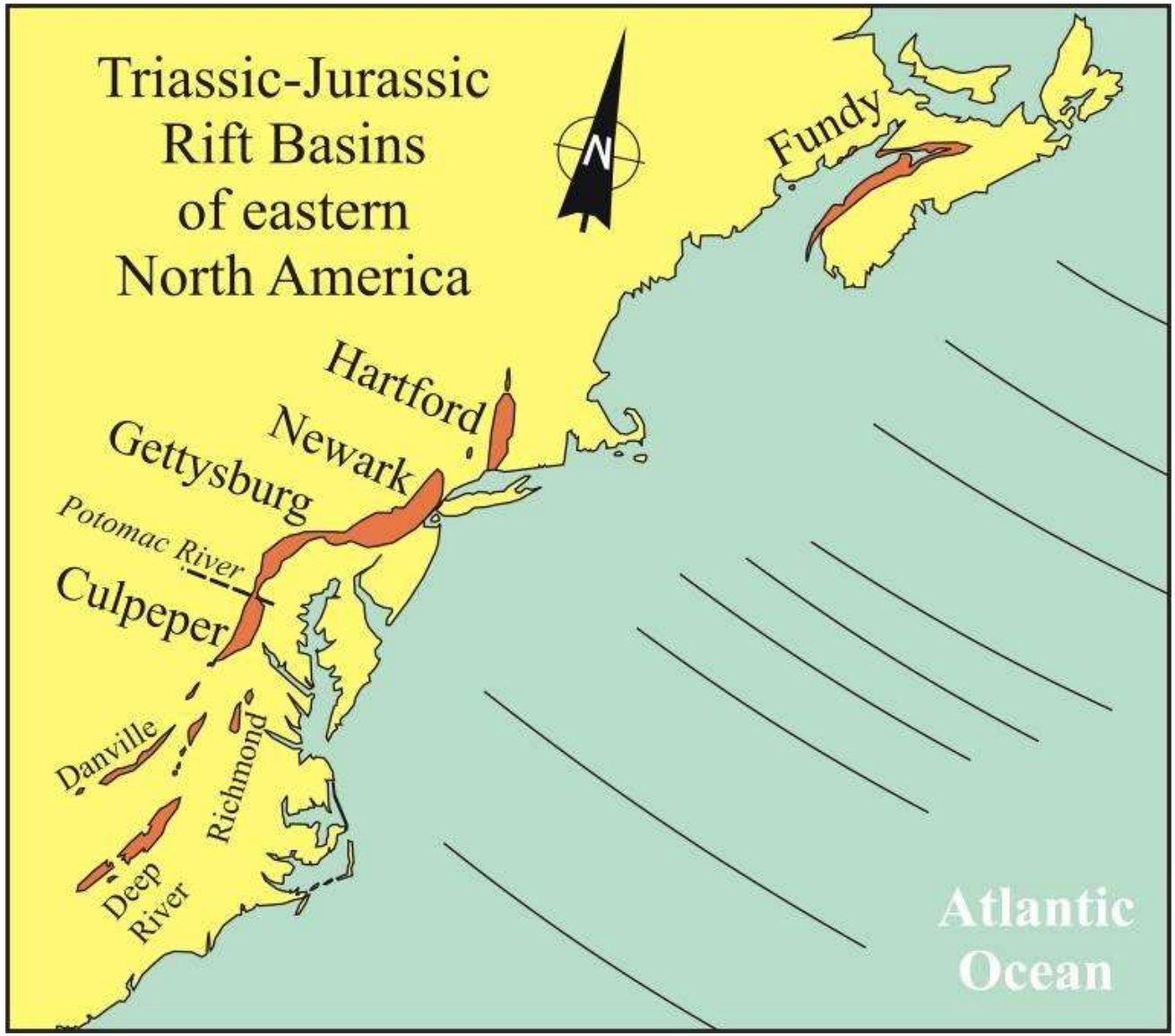
Role of Hot Spots

Timing of the breakup of Pangaea along various rift zones and the plume volcanism that was associated with each period of continental fragmentation. In most cases, volcanism appears to precede breakup by a few million years, or more.



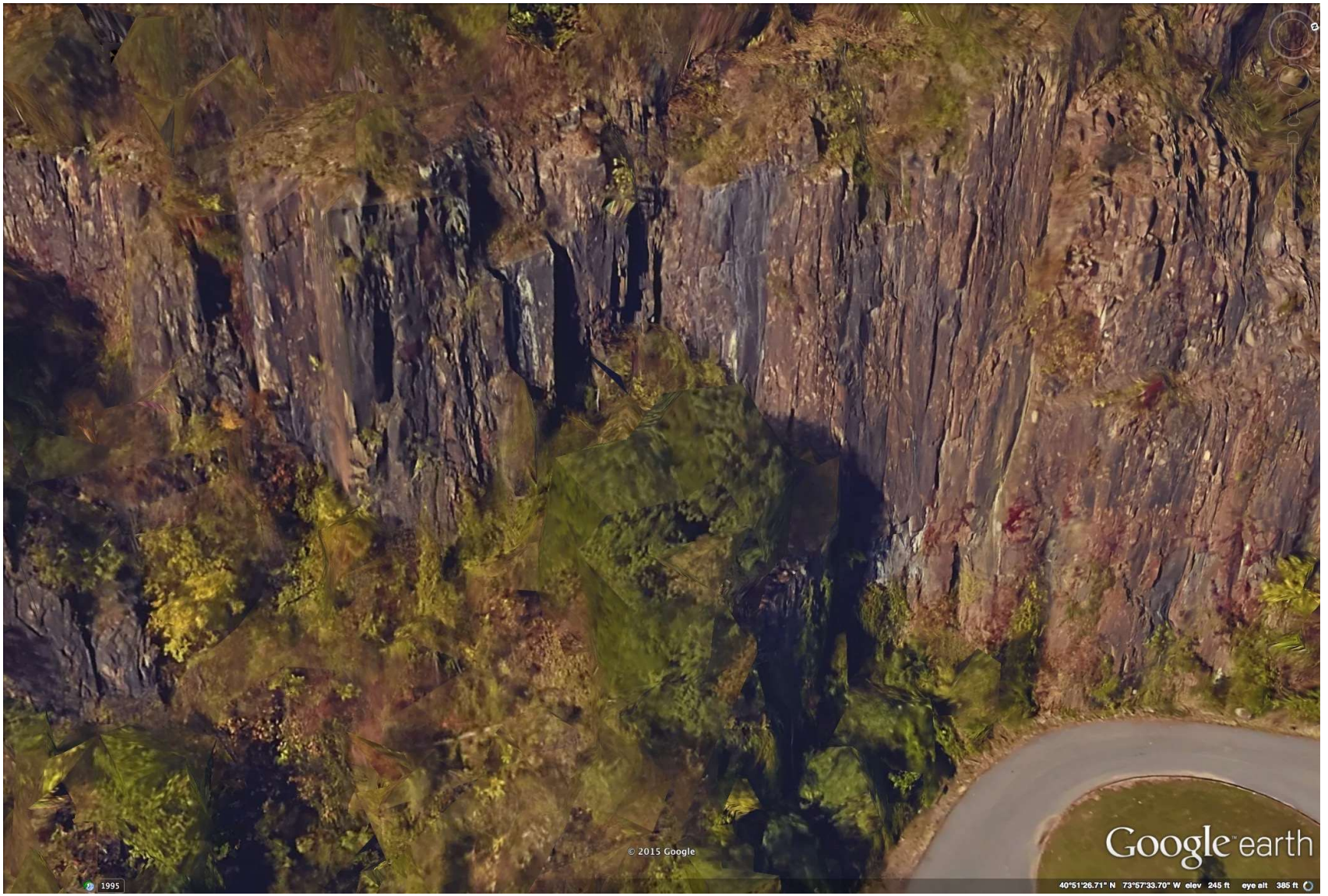
Breakup of Pangaea

Effects of Rifting - Basalt Flows



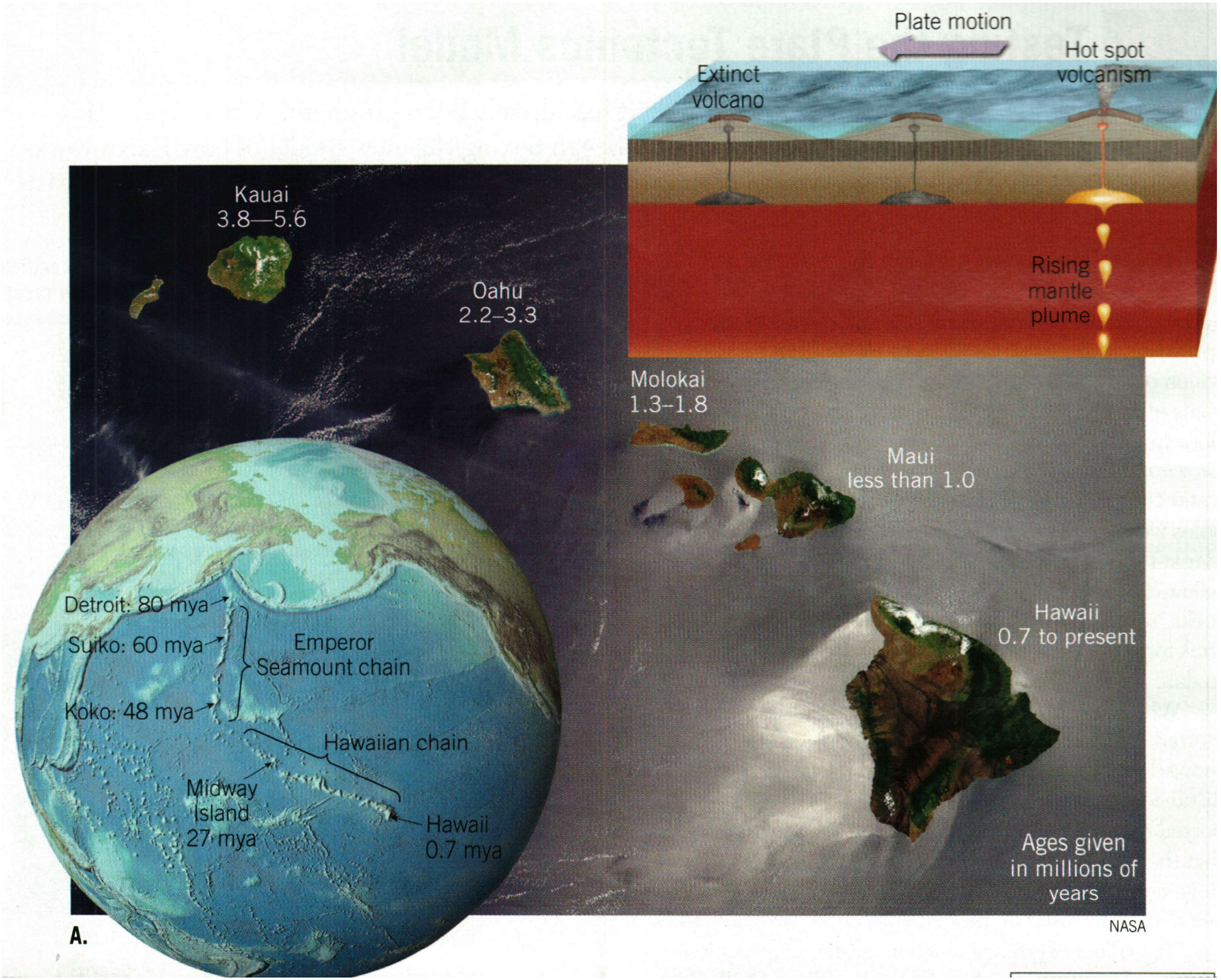
Breakup of Pangaea

Palisades, New Jersey

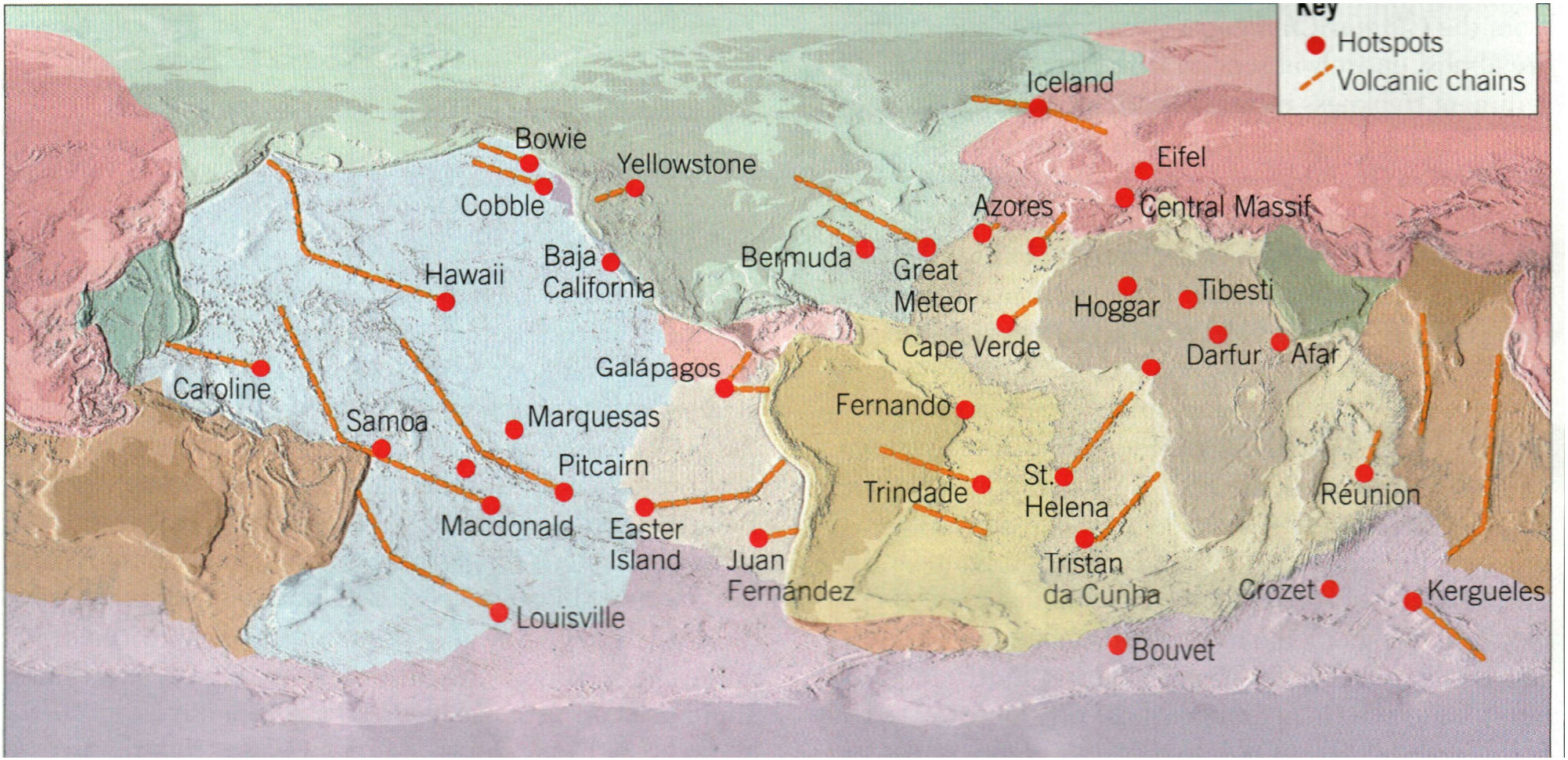


Hot Spots

Hawaii



Hot Spots


Key
Hotspots
Volcanic chains
Iceland
Bowie
Yellowstone
Eifel
Cobble
Azores
Central Massif
Baja California
Bermuda
Great Meteor
Hawaii
Hoggar
Tibesti
Cape Verde
Darfur
Afar
Galápagos
Caroline
Fernando
Samoa
Marquesas
Pitcairn
St. Helena
Trindade
Réunion
Macdonald
Easter Island
Juan Fernández
Tristan da Cunha
Crozet
Kergueles
Louisville
Bouvet

Hot Spots

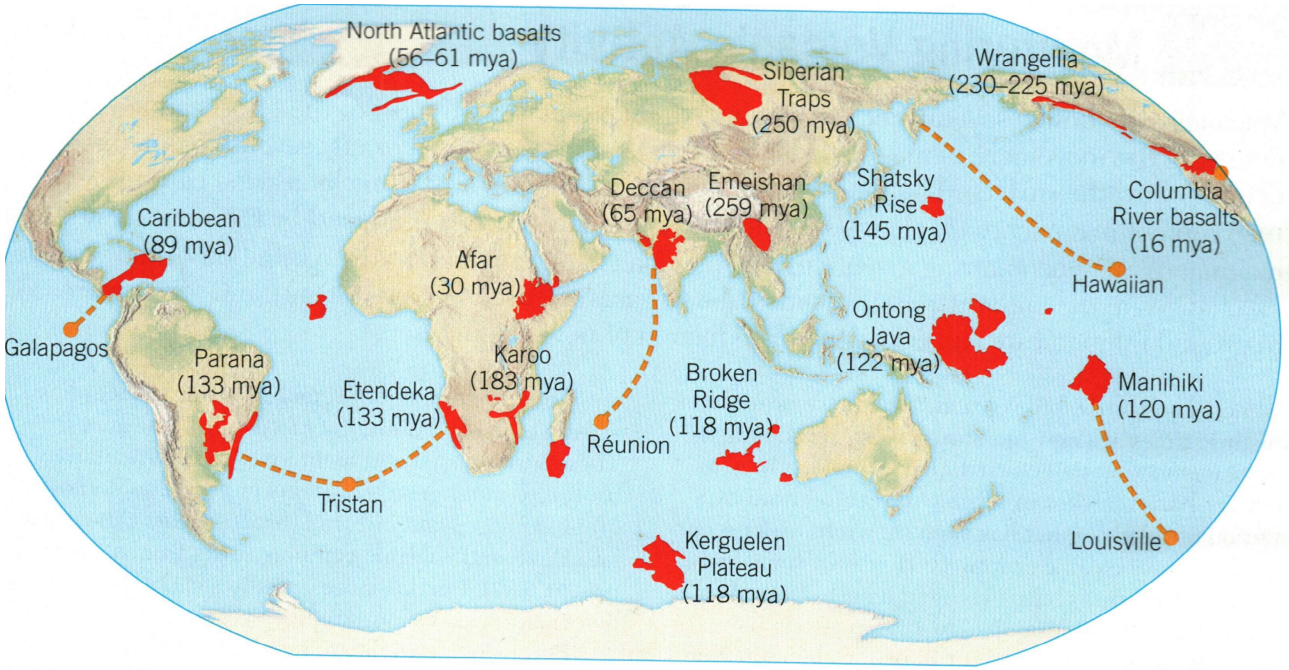
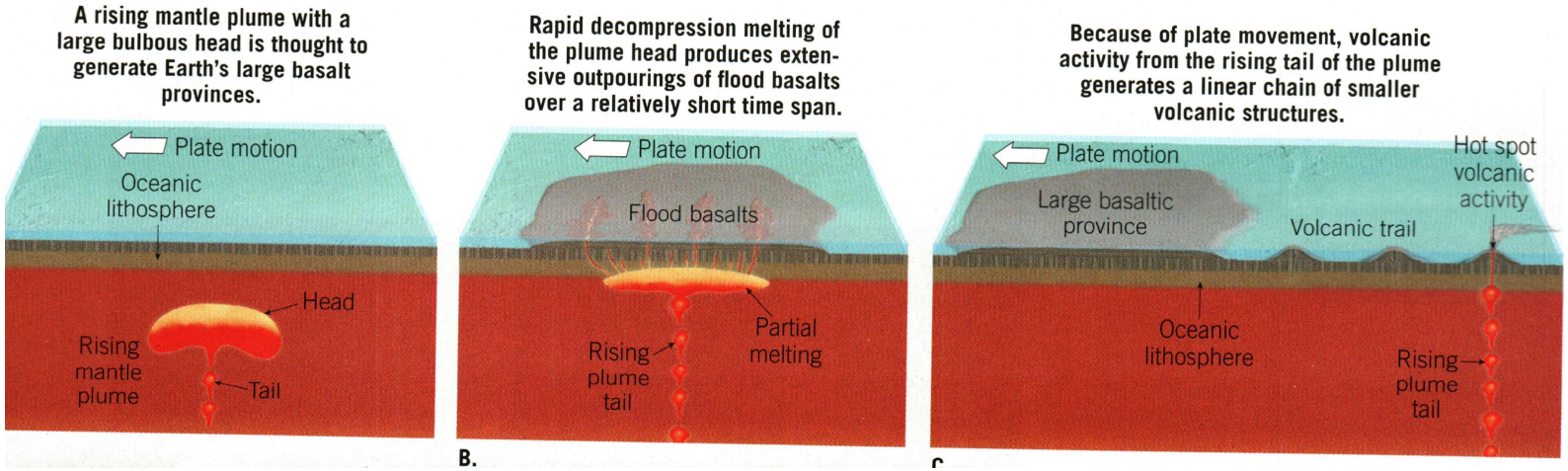
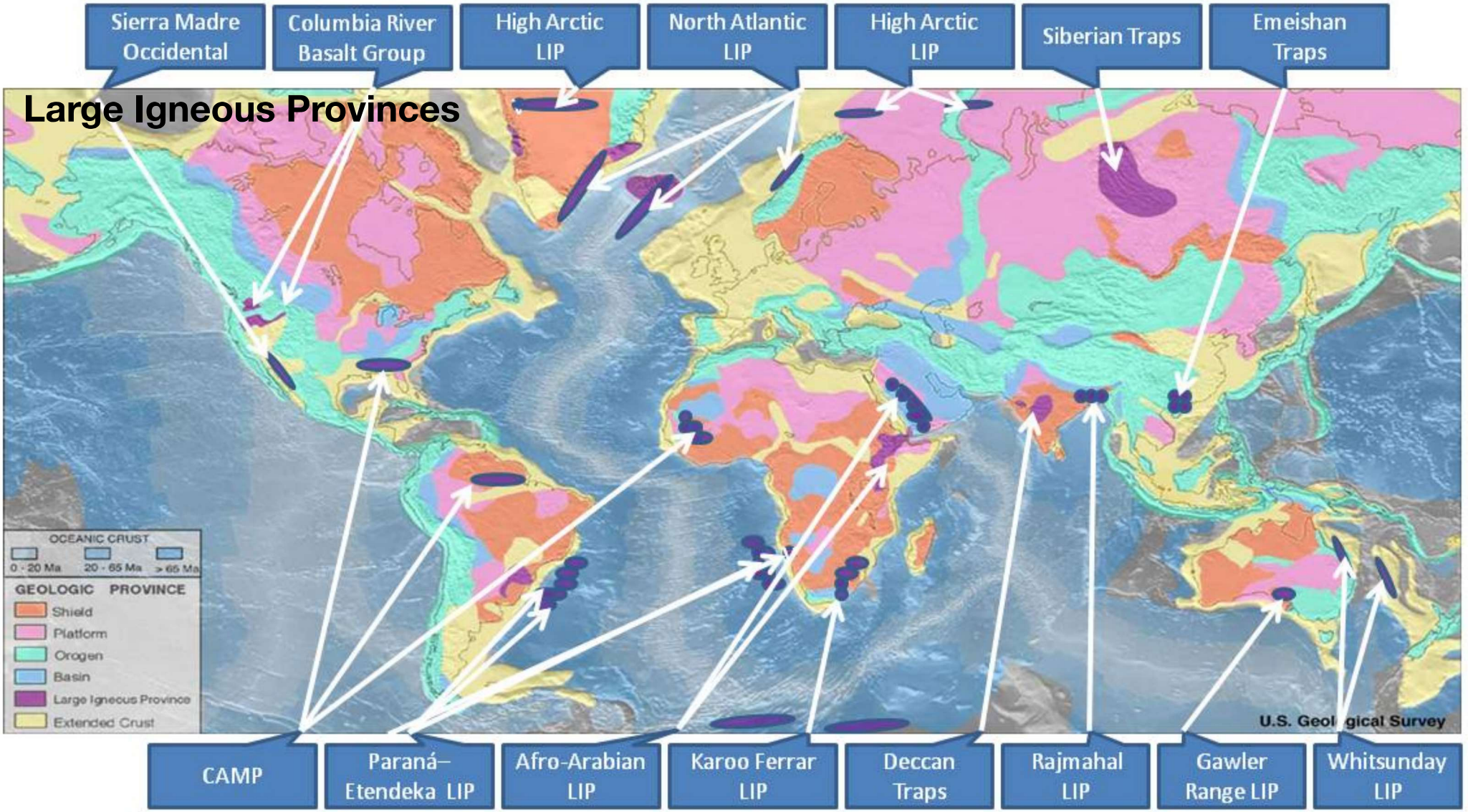


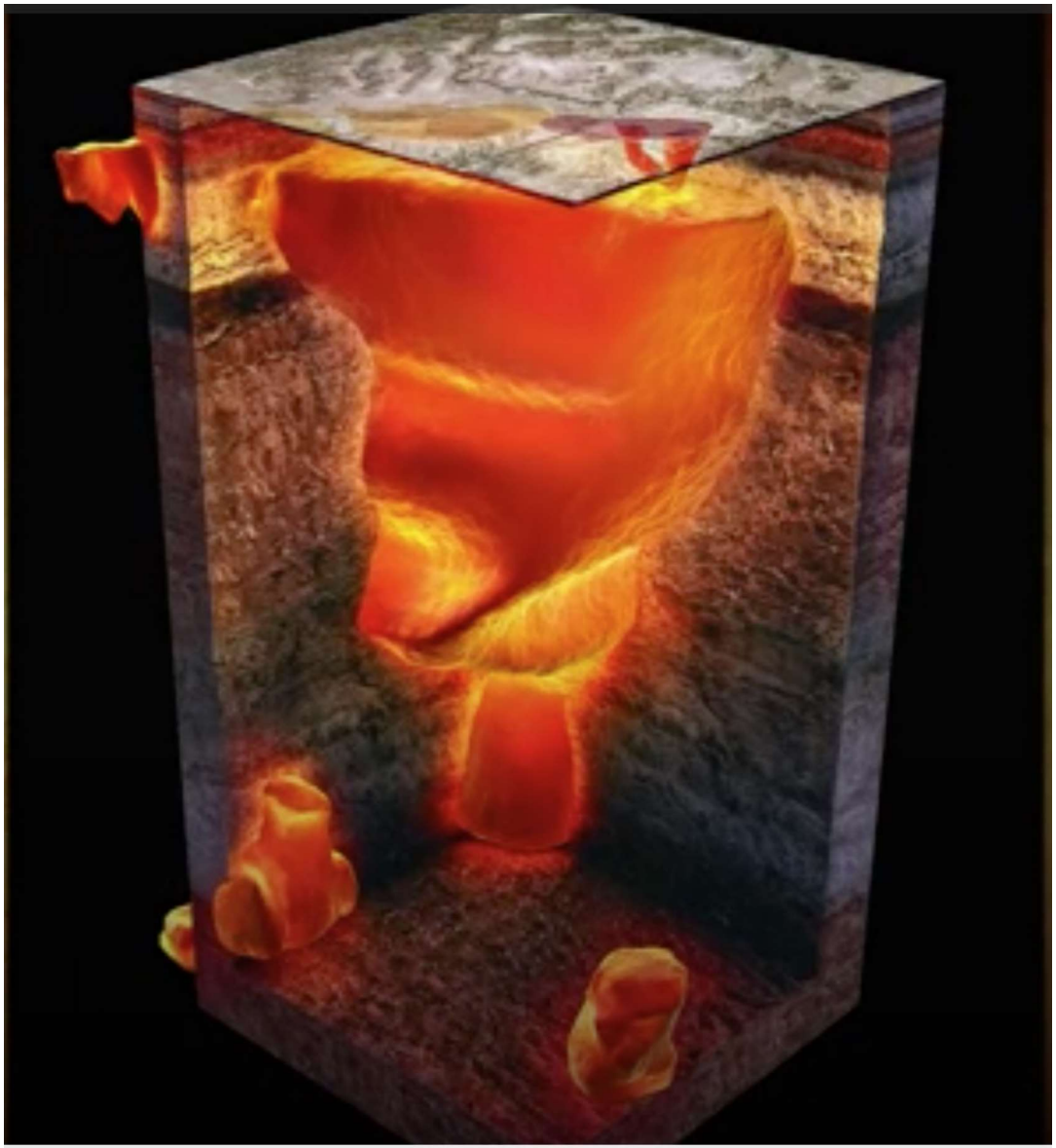
FIGURE 5.30 Large basalt provinces
Global distribution of large basalt provinces.



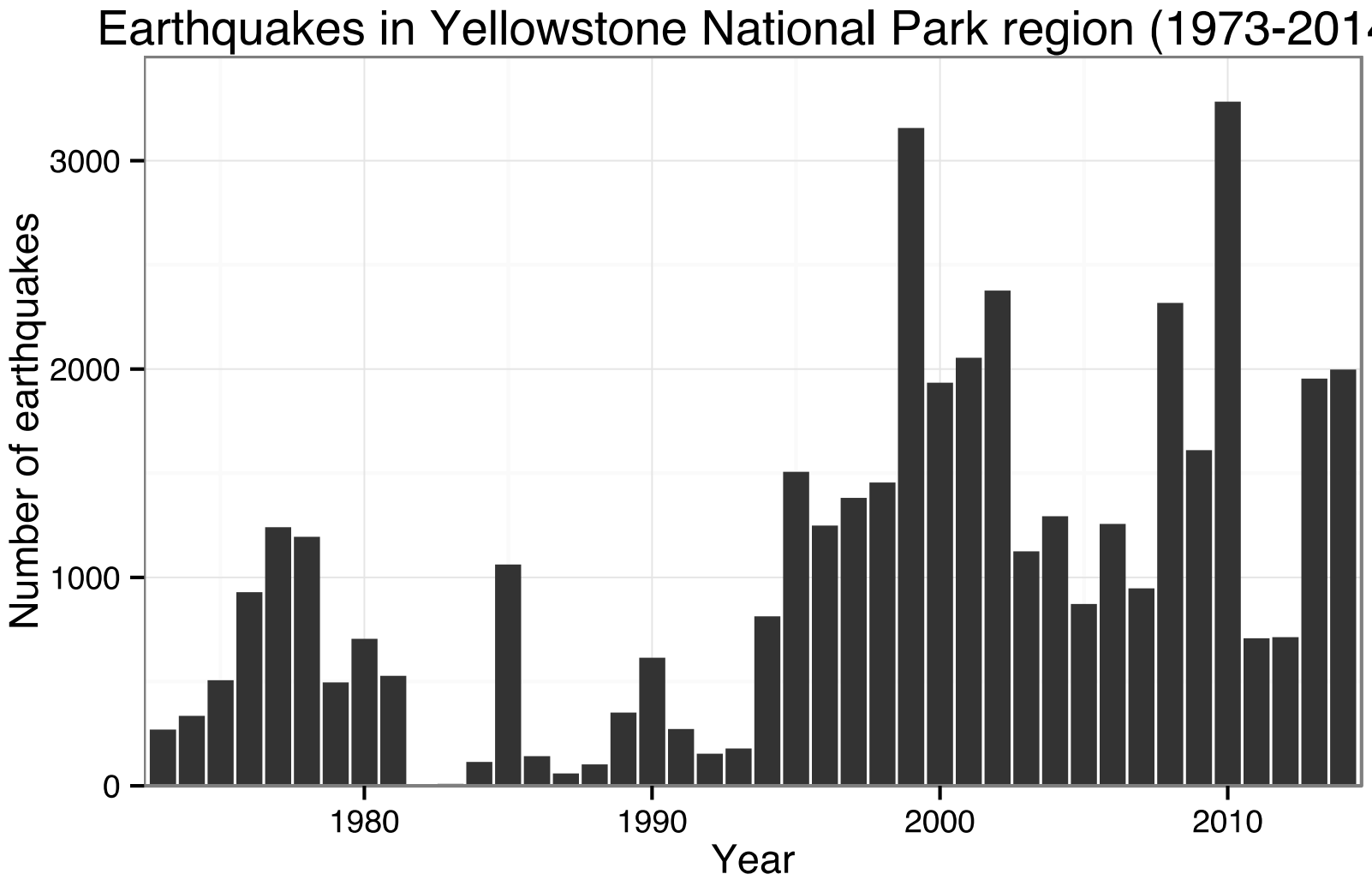

Large Igneous Provinces
Sierra Madre Occidental
Columbia River Basalt Group
High Arctic LIP
North Atlantic LIP
High Arctic LIP
Siberian Traps
Emeishan Traps
OCEANIC CRUST
0 - 20 Ma
20 - 65 Ma
> 65 Ma
GEOLOGIC PROVINCE
Shield
Platform
Orogen
Basin
Large Igneous Province
Extended Crust
U.S. Geol gical Survey
CAMP
Paraná–Etendeka LIP
Afro-Arabian LIP
Karoo Ferrar LIP
Deccan Traps
Rajmahal LIP
Gawler Range LIP
Whitsunday LIP

Yellowstone Hot Spot

Magma Chamber

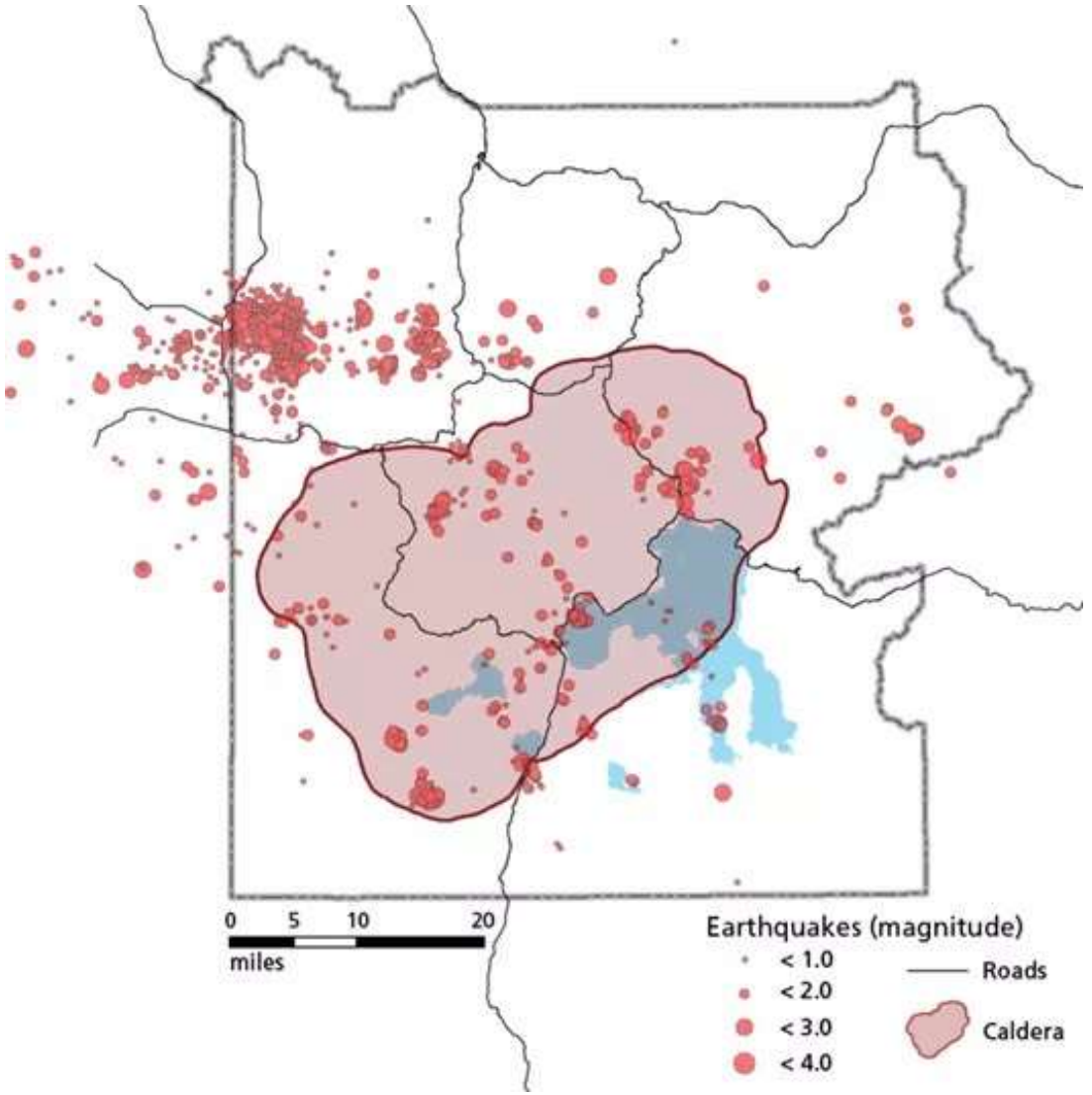


Yellowstone Hot Spot



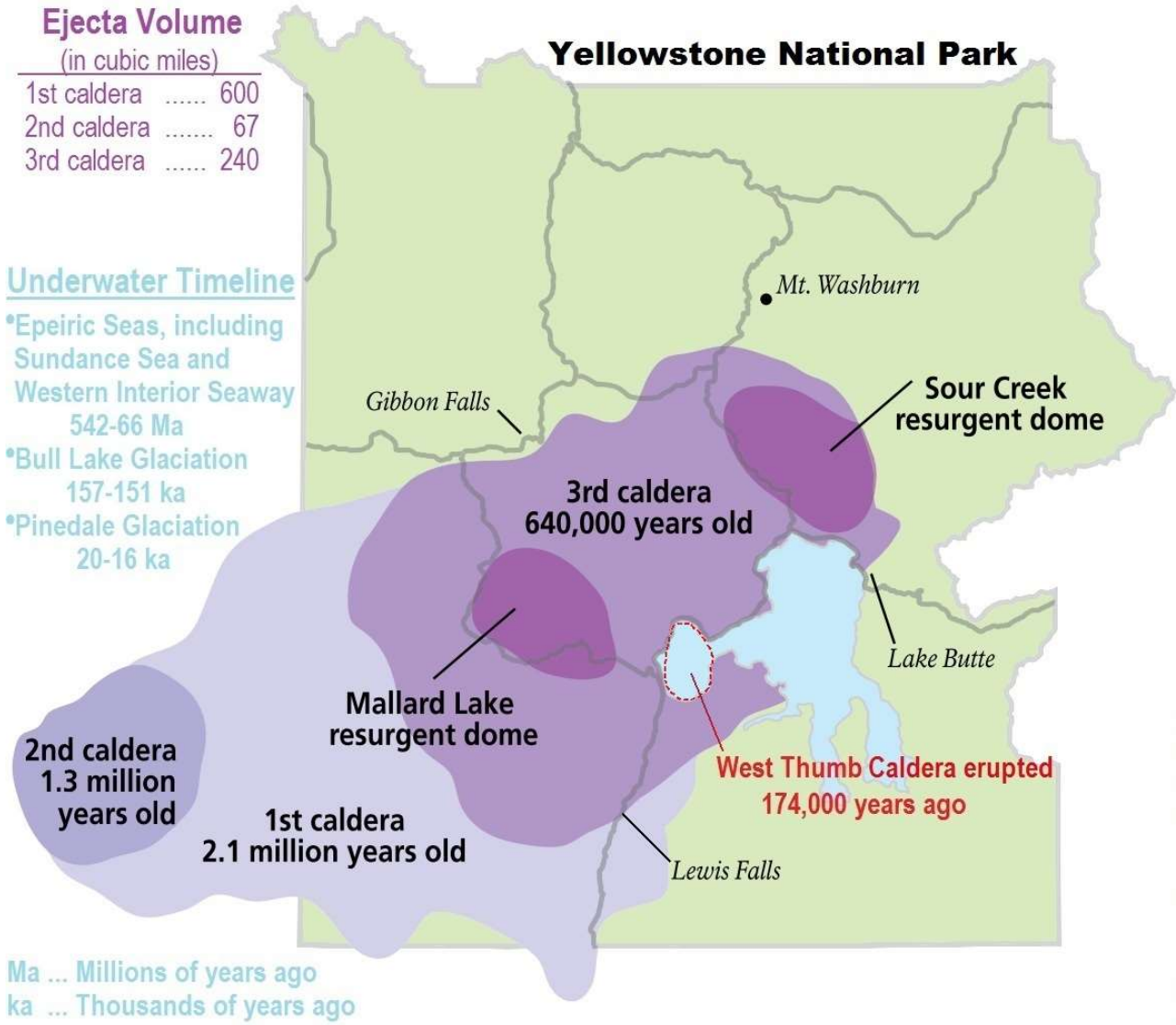
Yellowstone Hot Spot

Recent Earthquakes



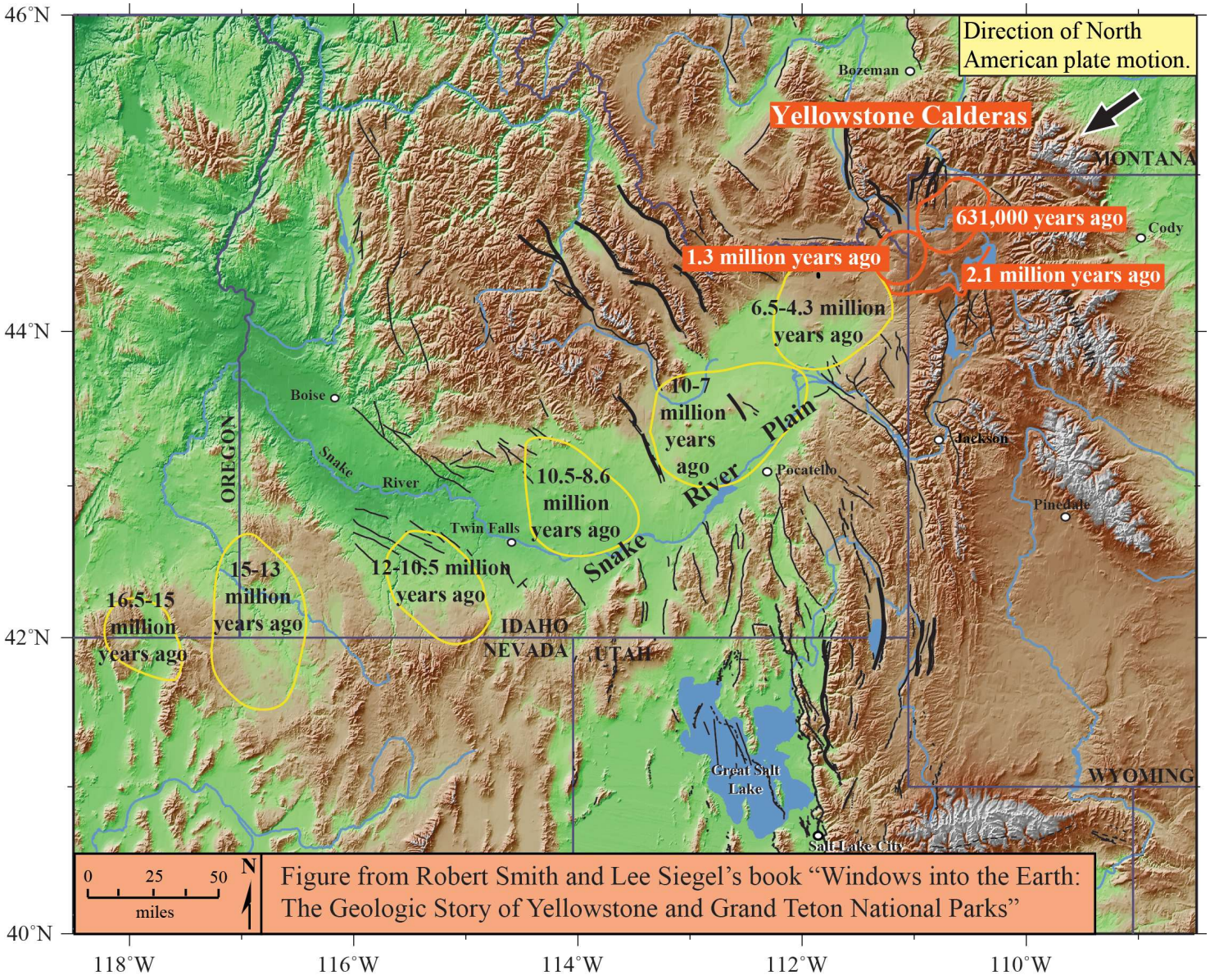
Yellowstone Hot Spot

Caldera



Yellowstone Hot Spot

Hot Spot Path



Yellowstone Hot Spot

- Cochran video 2.1 - from 17:39 to 18:18
- Cochran video 2.2 - from 21:18 to 21:55
- Cochran video 2.3 - from 22:18 to 25:04
- Cochran video 2.4 - from 29:14 to 30:54

Up Next

- Convergent Boundaries - The plate tectonics of the Mediterranean and Italy.